ments on various drafts of this report and to Wendy Woolfrey for advice on NSW's *Native Vegetation Act*.

Note

[1] Botanical nomenclature follows that of Harden (1990-93).

References

Allcock K, Board D, Hik D, Newsome A and Pech R (1999) Restoration based on ecological function: grazing management in an endangered Australian ecosystem. *Proceedings 24th Annual Meeting of the Canadian Land Reclamation Society, Saskatoon, 28-30 September 1999.*

Boland DJ, Brooker MIH, Turnbull JW and Kleinig DA (1980) *Eucalyptus Seed.* (CSIRO: Australia)

Burrows GE (1995) Seed production in white box (*Eucalyptus albens*) in the South West Slopes region of New South Wales. *Australian Forestry Journal* **58**, 107-109.

Curtis D (1990) Natural regeneration of eucalypts in the New England region. In *Sowing the Seeds*, pp.7-16. (Greening Australia: Deakin, ACT)

Florence RG (1996) *Ecology and Silviculture of Eucalypt Forests.* (CSIRO Publishing: Collingwood, Victoria)

Harden GJ (ed) (1990-93) *Flora of New South Wales* Volumes 1 to 4. (University of NSW Press: Kensington)

Jacobs MR (1955) *Growth Habits of the Eucalypts.* (Forestry and Timber Bureau / Commonwealth Government Printer: Canberra, ACT)

Lunt ID, Eldridge DJ, Morgan JW and Witt GB (2007) A framework to predict the effects of livestock grazing and grazing exclusion on conservation values in natural ecosystems in Australia. *Australian Journal of Botany* **55**, 401-415.

Prober SM (1996) Conservation of the grassy white box woodlands: rangewide floristic variation and implications for reserve design. *Australian Journal of Botany* **44**, 57-77.

Prober SM and Thiele KR (1993) The ecology and genetics of remnant grassy White Box woodlands in relation to their conservation. *The Victorian Naturalist* **110**, 30-36.

Semple WS and Koen TB (2001) Growth rate and effect of sheep browsing on young eucalypts in an anthropogenic *Themeda* grassland. *The Rangeland Journal* **23**, 182-193.

Semple WS, Koen TB and Henderson J (2007) Seed fall and flowering in white box (*Eucalyptus albens* Benth.) trees near Cowra, New South Wales. *Australian Forestry* **70**, 242-252.

Received 1 November 2007; accepted 15 May 2008

Water Rats as predators of Little Penguins

Tiana Preston

School of Biological Sciences, Monash University, Clayton, Victoria 3800
Email: tiana.preston@sci.monash.edu.au

Abstract

Water Rats are widely distributed throughout a variety of habitats and are known to be opportunistic predators. Their occupation in coastal areas often occurs within Little Penguin colonies, but interactions between the two species have not previously been reported. Given that Water Rats prey on other bird species, it is likely that they will also take young or weak Little Penguins. Here the case of a Little Penguin chick death that has been attributed to an attack by a Water Rat is reported. (*The Victorian Naturalist* **125** (6), 2008, 165-168).

Keywords: Water Rat, penguin, predation

Introduction

The native Water Rat *Hydromys chrysogaster* is an opportunistic predator, known to eat insects, crustaceans, fish, spiders, frogs, bats, shellfish, turtles, birds, carrion and some plant material (Woollard *et al.* 1978; Dickman *et al.* 2000). Widely distributed throughout Australia, Water Rats are considered common in large cities (Menkhorst and Knight 2001), occupying a variety of freshwater, estuarine and marine environments (Scebeck and Menkhorst 2000). Often inhabitants of coastal areas, the range of the Water Rat sometimes overlaps with that of sea-birds such as Silver Gulls *Larus novaehollandiae*, Short-tailed Shearwaters *Puffinus tenuirostris* and Little Penguins *Eudyptula minor* (Woollard *et al.* 1978; Wilson and Duffell 2005). Although Water Rats have previously been reported taking shearwaters, ducks, domestic fowl and a number of waterfowl (Woollard *et al.* 1978), there has been no report of them preying on Little Penguins.

Water Rats are known to live within the Little Penguin colonies at Phillip Island (P Dann, pers. comm.), Cat Island (Wilson and

Duffell 2005) and St Kilda (present study). The number of sites where the two species co-exist is probably much greater, given their overlapping distribution in south-eastern Australia. It has long been postulated that the Water Rats may take vulnerable penguin chicks and eggs, but until now no evidence to support this theory has existed. A case of predation on a Little Penguin chick by a Water Rat at the St Kilda breakwater is reported here.

Site Description

A small population of Water Rats lives on the artificially constructed breakwater wall at St Kilda (37°51'S, 144°57'E), 5 km from Melbourne. The breakwater wall is made up of large boulders and extends approximately 640 m from the end of the St Kilda pier. The population of Water Rats on the breakwater fluctuates, with up to nine individuals sighted in a night (unpubl. data). It is unknown whether the Water Rats breed on the breakwater wall, but juveniles have been seen in the area (pers. obs.). The Water Rats probably swim between the breakwater and shore, where they are commonly seen in a number of nearby drains and canals. Water Rats have been observed only within the sheltered harbour, as wave conditions around the outer wall of the breakwater make observations difficult.

The breakwater wall at St Kilda is also home to a colony of approximately 820 Little Penguins (ZM Hogg, unpubl. data). The Little Penguins have been nesting on the breakwater wall since at least 1974 (Eades 1975). Most of the penguin colony is fenced to prevent attacks by dogs and vandals. The only other vertebrates to reside on the breakwater are Silver Gulls and Little Ravens *Corvus mellori*, but their occupancy is sporadic. The breakwater is free from other native and introduced penguin predators.

Observations

During routine study of penguins in the 2007 breeding season, a Water Rat was observed on the breakwater near a penguin nest containing two post-guard chicks. Two penguins suspected of being the parents were observed returning from sea, but were not seen to approach the rat. The penguins and rat were not watched any further for fear of disturbing chick feeding. Upon return to the same nest two days later, one penguin chick was found dead inside the nest. The remaining chick showed no sign of injury and had put on weight since the previous visit. An adult penguin was also found in the nest, although the penguin chicks were originally left unguarded 15 days prior.

The downy chick weighed 840 g on the last day it was seen alive, its body recovered two days later weighed 620 g. The carcass was found extremely disfigured (Fig. 1); the head and neck had been attacked and eaten, and there were several holes in the back and around the left leg of the penguin. On initial recovery, the holes showed some signs of small teeth marks, but photographs were unable to show these as the skin quickly shrivelled with heat once the body was removed from the nest. Muscle and internal organs had been eaten through the holes in the back. Although damage to the chick was extensive, the body had not been completely stripped of flesh.

Post-guard chicks will often run to evade capture, but in this case the chick was found backed inside the nest. For the two weeks that the chick was left unguarded, it displayed both avoidance and defensive behaviour during regular weighing and handling. The amount of damage caused to the head (Fig. 2) indicates that the chick did try to defend itself by pecking whilst being attacked, but the bill of a penguin chick is too small to do any serious damage to a predator.

Water Rats are the only toothed animals observed on the breakwater (pers. obs.). The small teeth marks observed on the body, together with the sighting of a Water Rat in the immediate vicinity of the attack, lead to the conclusion that the chick was preyed on by a Water Rat.

Both Water Rats and Little Penguins have been studied at this colony, but until now predation by the rats on the penguins had not been observed. Penguins and Water Rats display very little interaction. The two species often swim past each other near the breakwater, as the penguins return from sea at dusk, which is also the time of peak foraging activity in the Water Rat (Olsen 1995). Neither penguins nor

Water Rats show any obvious signs of avoidance or defence upon encountering the other species in the water (pers. obs.). There have been very few sightings of penguin and Water Rat interaction on land, with penguins tending to be more timid and deliberately avoiding other animals once out of the water (pers. obs.).

Water Rats on the breakwater are suspected of taking penguin eggs when they disappear from nests or are found broken with the contents consumed. However, there is no direct evidence for this. It is likely that some eggs are taken by the ravens that occupy the breakwater periodically, or the penguins themselves may remove abandoned eggs from nests. Whether Water Rats take penguin eggs may also depend on whether the eggs are cracked, as observed by Woollard *et al.* (1978). Likewise, penguin chicks often disappear from their nests, but it is not known what has taken them or whether they have moved of their own accord, which often happens as the chicks become more mobile (Reilly and Cullen 1981).

Water Rats do not appear to kill a large number of penguin chicks, despite their being available for approximately seven months a year at St Kilda. Little Penguin chicks are vulnerable and approximately half die prior to fledging (Dann *et al.* 2000), but in 21 years of penguin study at this colony, this is the first reported instance of Water Rat predation on the penguins. Young penguin chicks are guarded by adults, which are unlikely to be attacked by Water Rats due to their vigorous defence. The main prey of the Water Rat at St Kilda appears to be marine invertebrates and crustaceans (A McCutcheon, pers. obs.), with penguin eggs and chicks probably an infrequent and opportunistic addition. Within penguin colonies it is likely that the Water Rats will feed on eggs and chicks occasionally, but a lack of evidence for these attacks suggests that they are not a significant predator of Little Penguins.

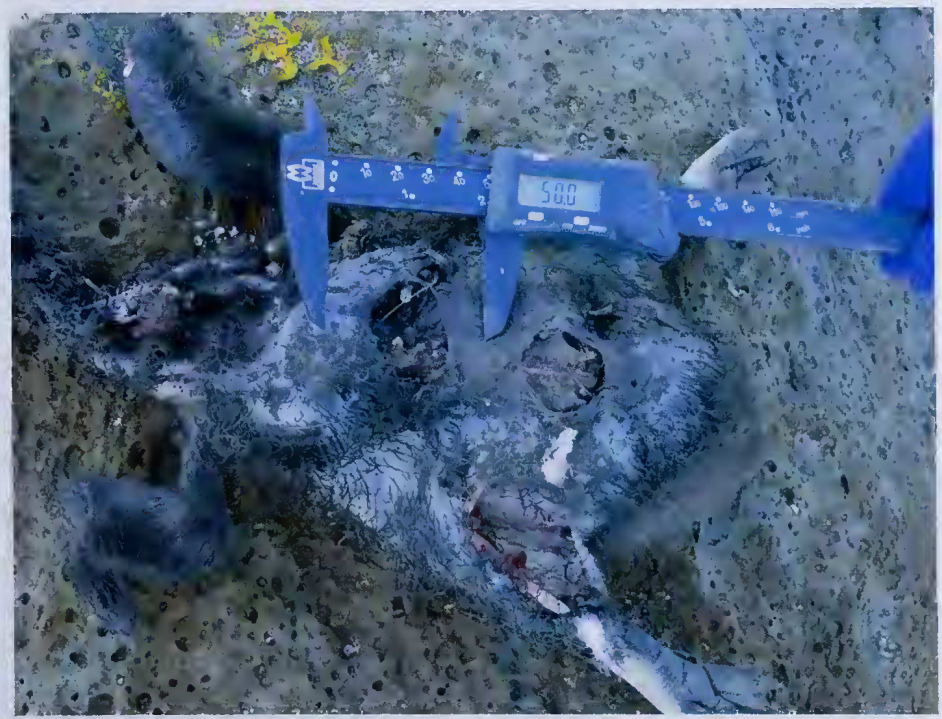

Fig. 1. Carcass of Little Penguin chick showing holes in its back where it was attacked by a Water Rat. Photo by Andrew McCutcheon.

Fig. 2. Front of penguin chick carcass showing extensive damage to the head. Photo by Andrew McCutcheon.

Acknowledgements

Penguins were handled as part of a PhD study supervised by Monash University and Phillip Island Nature Parks under DSE permits 10003374 and 10003848. Access to the breakwater was kindly granted by the St Kilda Breakwater Wildlife Management Co-operative Area committee. Thank you to Andrew McCutcheon for photographing the penguin and to Earthcare's Rakali Watch Team for promoting awareness of and education about the Water Rat.

References

Dann P, Norman FI, Cullen JM, Neira FJ and Chiaradia A (2000) Mortality and breeding failure of little penguins, *Eudyptula minor*, in Victoria, 1995-96, following a widespread mortality of pilchard, *Sardinops sagax*. *Marine and Freshwater Research* **51**, 355-362.

Dickman C, Lunney D and Matthews A (2000) Ecological attributes and conservation of native rodents in New South Wales. *Wildlife Research* **27**, 347-355.

Eades D (1975) Fairy penguins (*Eudyptula minor*) breeding on St Kilda Pier. *The Bird Observer* **519**, 12.

Menkhorst P and Knight F (2001) *A field guide to the mammals of Australia*. (Oxford University Press: Melbourne)

Olsen P (1995) Water-rat. In *The Mammals of Australia*, pp. 628-629. Ed R Strahan. (Reed Books: Chatswood)

Reilly PN and Cullen JM (1981) The little penguin *Eudyptula minor* in Victoria, II: Breeding. *Emu* **81**, 1-19.

Seebeck J and Menkhorst P (2000) Status and conservation of the rodents in Victoria. *Wildlife Research* **27**, 357-369.

Wilson J and Duffell A (2005) Observations of movements of Water Rats *Hydromys chrysogaster* on Cat Island, Furneaux Group, Bass Strait, Tasmania. *The Victorian Naturalist* **122**, 209-211.

Woollard P, Vestjens WJM and MacLean L (1978) The ecology of the eastern water rat *Hydromys chrysogaster* at Griffith, NSW: Food and feeding habits. *Australian Wildlife Research* **5**, 59-73.

Received 29 November 2007; accepted 27 March 2008